U. S. ENVIRONMENTAL PROTECTION AGENCY
Washington, D.C. 20460

OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION
Decision #451547

Date: April 25, 2012
Chemical: Sodium Diacetate
PC Code: 044008
DP Barcode: D391552

MEMORANDUM

SUBJECT: **Registration Review – Qualitative Ecological Risk Assessment and Effects Determination of Sodium Diacetate**

TO: Melanie Biscoe, Chemical Review Manager
Anne Overstreet, Risk Manager
Pesticide Re-evaluation Division (7508P)

FROM: Meghan Radtke, Ph.D., Biologist 4/25/12
He Zhong, Ph.D., Biologist 4/25/2012
Environmental Risk Branch I
Environmental Fate and Effects Division (7507P)

THROUGH: Nancy Andrews, Ph.D., Branch Chief 4/25/12
Sujatha Sankula, Ph.D., Lead Biologist 4/25/12
Environmental Risk Branch I
Environmental Fate and Effects Division (7507P)

The Environmental Fate and Effects Division (EFED) has conducted a qualitative evaluation of sodium diacetate as a part of the registration review process and concluded that the use of this compound, based on the label directions, should not pose an unreasonable risk to non-target organisms. Sodium diacetate is a sodium acid salt of acetic acid, which readily dissociates into acetic acid and sodium acetate. It is applied to hay (stored in bales) to prevent spoilage, to silage as an aid in fermentation, and to preserve the quality of animal feeds such as field corn, alfalfa, sorghum, oats, and grasses that are stored in silos. It is also registered for use as a supplement to livestock/poultry feeds and dairy rations. Consequently, EFED concludes a "No Effect" determination for all currently registered uses of sodium diacetate for all non-target organisms.

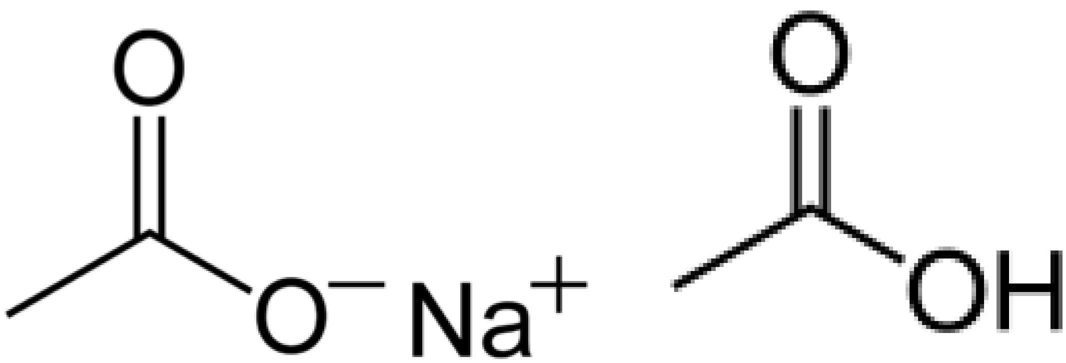
REGISTRATION REVIEW

ECOLOGICAL RISK ASSESSMENT AND EFFECTS DETERMINATION

Sodium Diacetate

CAS Number: 126-96-5

USEPA PC Code: 044008



PREPARED BY:
Meghan Radtke, Ph.D., Biologist
He Zhong, Ph.D., Biologist,
Environmental Risk Branch 1
Environmental Fate and Effects Division

PEER REVIEW TEAM:
Faruque Khan, Ph.D., Senior Scientist
Sujatha Sankula, Ph.D., Lead Biologist

APPROVED BY:
Nancy Andrews, Ph.D., Branch Chief
Environmental Risk Branch 1
Environmental Fate and Effects Division
Office of Pesticide Programs

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List of Abbreviated Terms and Symbols

%	symbol for “percent”
>	symbol for “greater than”
ºC	symbol for “degrees Celsius”
ai	active ingredient
bw	body weight
CI	confidence interval
DP	Data Package
EC_{50}	50% (or median) effect concentration
EFED	Environmental Fate and Effects Division
e.g.	Latin *exempli gratica* (“for example”)
et al.	Latin *et alii* (“and others”)
etc.	Latin *et cetera* (“and the rest” or “and so forth”)
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FQPA	Food Quality Protection Act
i.e.	Latin *id est* (“that is”)
kg	kilogram(s)
K_{oc}	symbol for the organic carbon partitioning coefficient
LAA	likely to adversely affect
lb ai/A	pound(s) of active ingredient per acre
IC_{50}	50% (or median) inhibition concentration
LC_{50}	50% (or median) lethal concentration
LD_{50}	50% (or median) lethal dose
LOC	level of concern
MA	may affect
mg	milligram(s)
mg/kg	milligrams per kilogram (equivalent to ppm)
mg/L	milligrams per liter (equivalent to ppm)
MRID	master record identification number
NASS	National Agricultural Statistics Service
NAWQA	National Water Quality Assessment
NE	no effect
NLAA	not likely to adversely affect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEC	no observable adverse effect concentration
NOAEL	no observable adverse effect level
OPP	Office of Pesticide Programs
OPPTS	Office of Prevention, Pesticides, and Toxic Substances

pH	symbol for the negative logarithm of the hydrogen ion activity in an aqueous solution, dimensionless
pKa	symbol for the negative logarithm of the acid dissociation constant, dimensionless
ppm	parts per million (equivalent to mg/L or mg/kg)
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
Wt	weight

Executive Summary

Nature of Stressor

The Agency has conducted a qualitative evaluation of sodium diacetate as a part of the registration review process and concluded that the use of this compound, based on the label directions, should not pose an unreasonable risk to non-target organisms. Sodium diacetate is a sodium acid salt of acetic acid, which readily dissociates into acetic acid and sodium acetate. Acetic acid is the active moiety of sodium diacetate, which acts as fungicide and bactericide to control molds and bacteria by temporarily changing the local acidity. Acetic acid is also a naturally occurring chemical in plants and animals and an integral part of the Kreb's cycle, forming adenosine-5-triphosphate (ATP) for energy. It is applied to hay (stored in bales) to prevent spoilage, to silage as an aid in fermentation, and to preserve the quality of animal feeds such as field corn, alfalfa, sorghum, oats, and grasses that are stored in silos. It is also registered for use as a supplement to livestock/poultry feeds and dairy rations.

Application rates of sodium diacetate for hay and grain preservation are dependent upon the moisture content of the grains at the time of storage; application rates are 2 to 3 lb ai/ton of feed/hay. Application is usually not recommended at moisture contents above 25% (hay), 35% (high moisture ensiled corn) and 70% (silage). For dairy rations, the maximum application rate is 2 lb ai/ton.

Use Information

Sodium diacetate is applied to crops post harvest. For baled hay preservation, application occurs at the time of baling in the field. Bales are then either stored outside, covered in plastic, or moved to sheds until needed. As a feed supplement for poultry, livestock, and dairy rations, sodium diacetate is added directly to the feed, either during the grinder/mixer stage or as a top dressing (dairy rations only). Lastly, sodium diacetate can be used for the preservation of processed corn, hay, sorghum, oat, and grass silages that are to be stored in a conventional upright, oxygen limiting pit and bunker silo. These applications occur at the time of chopping or at the blower when the silage is being loaded into the silo.

Physical and Chemical Properties

Sodium diacetate ($CH_3COONaCH_3COOH$) is described as a 1:1 mixture of sodium acetate and acetic acid, and is stable at ambient temperature. It is a white, hygroscopic, crystalline solid having an odor of acetic acid. The pH in a 10% (w/v) solution is 4.5-5.0 and gives positive tests for acetate and sodium. The molecular weight is 143.1 g/mole and the melting point is 150.55º C (Table 1). It is readily soluble in water (1g/ml), slightly soluble in alcohol, and insoluble in ether (USEPA 1991). One gram of sodium diacetate is soluble in about 1 ml of water, liberating its major degradates – acetic acid (CH_3COOH) and sodium acetate (CH_3COONa). Acetic acid is also registered as a non-selective herbicide for control of broadleaf weeds and weed grasses to residential, golf courses, non-crop, right of way and industrial land sites (USEPA 2008).

Acetic acid is a naturally occurring compound in plants and animals with a fundamental role in cell metabolism, particularly in the tricarboxylic cycle (Kreb's cycle). At 25 ºC, the solubility of acetic acid is 1.00E-06, the vapor pressure is 15.7 mm Hg, the Henry's Law Constant is 1.00E-07 atm-m^3/mole and the pKa dissociation constant is 4.76 (TOXNET) (Table 1). As acetic acid enters the tricarboxylic cycle, the acetyl molecule is broken down and serves as a source of energy transformed into ATP. In contrast, the anabolic production of fatty acids in plants and animals also involves the incorporation of two carbon acetyl molecules; however, when acetic acid is sprayed on terrestrial plants, it disrupts the integrity of the cell membrane and results in leakage of cellular fluids, causing the plant to dry out. Acetic acid has toxic effects on the central nervous system and kidneys (Clayton and Clayton 1982). Acetic acid is a weak acid and capable of affecting local pH.

The by-products from environmental degradation of acetic acid are dependent on redox potential (Lindsay 1979). The estimated half-lives of acetic acid are about 17.3 days in soil and 8.7 days in water (EPI Suite 4.1). In oxic and suboxic environments, CO(g), $HCOO^-$, and $C_2O_4^-$ are transient degradation products with eventual formation to CO_2. Ethane (C_2H_4) formation occurs only at extremely low redox conditions. Under anoxic conditions, methane is produced from acetic acid. Another major degradate, sodium acetate, produces sodium cations and acetate anions. The sodium cations may combine with other reactive materials in the soil. Below are the two main reactions for acetic acid/acetate anion degradation:

Aerobic/Suboxic Conditions: $CH_3COO^- + 2H_2O$-------- $2\ CO_2 + 8e^- + 7H^+$ log $K^o = -9.64$
Anaerobic Condition: $CH_3COO^- + 8e^- + 9H^+$---------------$2CH_4(g) + 2H_2O$ log $K^o = 36.19$

Table 1. Physical and Chemical Properties of Sodium Diacetate and Acetic Acid (Major Degradation Product).

Parameter	Value	Reference
Sodium Diacetate (Parent)		
Chemical Name	Sodium Diacetate	MRID 2058971
CAS Number	126-96-5	TOXNET
Molecular Formula	$CH_3COONaCH_3COOH$	MRID 2058971
Molecular Weight	143.1 g/mole	TOXNET
SMILES Code	C(O)(=O)C.C(C)(=O)[O-].[Na+]	TOXNET
Melting Point (ºC)	150.55	EPI Suite (v 4.10)
Boiling Point (ºC)	424.96	EPI Suite (v 4.10)
Vapor pressure (25°C)	1.08×10^{-7} mm Hg @ 25ºC	EPI Suite (v 4.10)
Henry's Constant	9.27×10^{-9} atm m^3 $mole^{-1}$	EPI Suite (v 4.10)
Solubility (25ºC)	1kg/L	MRID 2058971
K_{oc}	1 ml/g (mean)	EPI Suite (v 4.10)

Parameter	Value	Reference
Acetic Acid (Major degradate)		
Chemical Name	Acetic Acid	MRID 2058971
CAS Number	64-19-7	TOXNET
Molecular formula	$C_2H_4O_2$	EPI Suite (v 4.10)
Molecular weight	60.5 g/mol	EPI Suite (v 4.10)
SMILES Code	O=C(O)C	EPI Suite (v 4.10)
Melting Point (ºC)	16.6	TOXNET
Boiling Point (ºC)	117.9	TOXNET
Vapor pressure (20/25°C)	15.7 mm Hg @ 25ºC	TOXNET
Henry's Law Constant	1.0×10^{-7}	TOXNET
Solubility (25ºC)	1.0×10^{6} mg/L	TOXNET
K_{oc}	1 ml/g (mean)	EPI Suite (v 4.10)

Ecotoxicity Data

One registrant-submitted study is available for sodium diacetate. A rat acute oral toxicity study demonstrated an LD_{50} of 5600 mg ai/kg, classifying the chemical as practically non-toxic to mammals. An open literature search did not yield any additional data specifically for sodium diacetate.

Several registrant-submitted and open literature studies are available for sodium diacetate degradates – acetic acid and sodium acetate. These studies present a relatively benign picture of the two degradates. Acute data for freshwater fish (MRID 48770801), freshwater mollusks (Cairns et al. 1976), estuarine/marine fish (Locke et al. 2009), and estuarine/marine invertebrates (Locke et al. 2009) all classify acetic acid as slightly toxic to practically non-toxic. Acetic acid is classified as slightly toxic to freshwater oligochaete worms (MRID 48770801) and freshwater invertebrates (MRID 48770802). For terrestrial insects, an acute exposure of 26,225 mg ai/hive showed no mortality in honey bees nor the *varroa* mites inhabiting the hive (van Engelsdorp *et al.* 2008). Toxicity data for freshwater vascular plants, non-target algae, and freshwater diatoms are IC_{50} = 549 mg ai/L, 4000 mg ai/L, and 74 mg ai/L, respectively. No toxicity studies were available for terrestrial plants, although Stopar (2008) reported necrosis and chlorosis on apple leaves that were exposed to acetic acid. This aligns with acetic acid's registration as a non-selective herbicide (USEPA 2010, DP 367372).

Chronic exposure to sodium diacetate and its degradates is not expected, based on the short half-life of acetic acid.

When the Reregistration Eligibility Document for sodium diacetate was published in 1991, it was determined that there was sufficient knowledge to conclude that sodium diacetate was "slightly toxic to practically non-toxic," and a regulatory decision was made that no further studies were needed.

Ecological Risk Conclusions

Potential risks are expected to be minimal from the registered uses of sodium diacetate. For treatments that occur on the field, the risk of toxicological exposure to non-target plants and aquatic organisms from runoff is low. Very high concentrations of acetic acid (major degradate) would be necessary to change the pH of an aquatic system and thus cause toxic responses; this response is not expected from the labeled application rate. In addition, acetic acid is practically non-toxic to freshwater fish, estuarine/marine fish, estuarine/marine invertebrates, vascular plants, and non-vascular plants (USEPA 2010). Incidental acute exposure to terrestrial wildlife that use the outdoor-stored, non-covered bales of hay as a resource (*e.g.,* food, shelter) is also low, given the short half life (the half life of acetic acid is approximately 17.3 days in soil and 8.7 days in water). Sodium diacetate is practically non-toxic to birds and mammals; acetic acid is practically non-toxic to terrestrial insects and birds. For the feed fermentation and dairy ration uses, applications usually occur indoors or directly at the site of the silo. All treated feed that is used for livestock and poultry has the potential to be placed in the troughs of outdoor feedlots, but given the domestic surroundings (*e.g.,* farm buildings, farm houses, animal houses), it is unlikely to come into contact with many non-target species; listed species are unlikely to frequent such built up areas. In short, even if an incidental exposure of sodium diacetate or acetic acid occurs through terrestrial or aquatic pathways, the potential effects are expected to be short lived, localized, and not likely to cause any adverse effects.

The following table lists the potential direct and indirect effects to listed species from use of sodium diacetate on grain/hay storage and feed (Table 2).

Table 2. Potential risks to non-listed and listed species associated with direct or indirect effects from the proposed application of sodium diacetate

Taxonomic Group	Effects Endpoint[1]	Direct Effects[2]		Indirect Effects to Listed Species	
		Non-Listed	Listed	Potential	Indirect Effects from Direct Effect to:[3]
Aquatic vascular plants	Measures of biomass	No	No	No	Not applicable
Aquatic non-vascular plants	Measures of biomass	No	No	No	Not applicable
Terrestrial plants	Measures of biomass-NA[4]	No	No	No	Not applicable
Freshwater vertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Estuarine/marine vertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Freshwater invertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Estuarine/marine invertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Mammals	Acute oral dose: mortality Sub-acute dietary: mortality and growth-NA Chronic: growth and reproduction-NA	No	No	No	Not applicable
Birds	Acute oral dose: mortality-NA Sub-acute dietary: mortality and growth Chronic: growth and reproduction-NA	No	No	No	Not applicable
Terrestrial invertebrates	Acute contact and oral: mortality	No	No	No	Not applicable

[1]Abbreviations: NA = toxicity data not available
[2]Negligible exposures to non-target organisms from sodium diacetate registered uses being indoors or contained (no spray drift, runoff, spillage). Therefore, adverse effects are not expected.
[3]Direct effects to species may result in indirect effects to other species by changing availability of prey, habitat, and other factors important to survival and reproduction.
[4]Acetic acid is registered as a non-selective herbicide, so it is expected that if directly applied to non-target plants, there could be adverse effects; however, the usage on hay/silage/feed is not expected to come into contact with non-target plants.

Therefore, a "no effect" determination has been concluded for federally listed species for the registered uses of sodium diacetate on the preservation of hay, silage, and as a food supplement for livestock, poultry, and dairy cows.

Introduction

Purpose of Assessment

The purpose of this assessment is to evaluate the potential risk to populations of non-listed (*i.e.,* not federally endangered or threatened) species, and endangered and threatened (listed) species from exposure to sodium diacetate and its degradates from its registered uses. Risks from direct and indirect effects are derived and evaluated in accordance with the risk assessment methodology described in the Agency's Overview Document (USEPA, 2004). These risk findings are then used as part of an "effects determination" for listed species. The Agency will reach one of the following three conclusions regarding the potential for the registered sodium diacetate use on non-food crops to affect federally listed species:

- "No effect;"
- "May affect, but not likely to adversely affect;" or
- "May affect, and likely to adversely affect."

If the results of the risk assessment show no indirect effects and the levels of concern (LOCs) are not exceeded for direct effects for the taxonomic grouping of a listed species (*e.g.,* freshwater fish, small herbivorous mammal), a "no effect" (NE) determination is made, based on sodium diacetate's use within the action area for that species. If, however, there is a potential for indirect effects and/or risk quotients exceed the listed species LOC values for direct effects for a given group, the Agency concludes a preliminary "may affect species" (MA) within the taxonomic group. The Agency then considers additional lines of evidence such as the geographical nature of the exposure, as well as more in-depth evaluations of the toxicological and ecological requirements to determine a rationale for a "not likely to adversely affect" (NLAA) or "likely to adversely affect" (LAA) determination.

Similarly, the Agency will reach one of the following conclusions regarding the potential for sodium diacetate's uses to result in destruction of adverse modification of critical habitat:

- "No adverse modification of critical habitat;"
- "May affect primary constituent elements."

The Agency uses the risk assessment analysis for direct effects to categories of biological resource requirements to draw conclusions about effects to primary constituent elements of critical habitat. The Agency is limited in a practical sense to those primary constituent elements of critical habitat that are of a biological nature. If the results of the risk assessment show that no LOC is exceeded for all taxonomic groups, a “no effect” (NE) determination for habitat modification is made. If an LOC is exceeded for one or more taxonomic groupings, the Agency then considers additional lines of evidence to determine the rationale for a “may affect primary constituent elements.” This evidence may include: the type and degree of effect on the taxonomic groups, expected resultant effects on biologically mediated environmental processes (*e.g.,* increased sedimentation from loss of vegetation) as compared to baseline environmental conditions, co-occurrence of the action area with critical habitat, or the type of principle constituent elements associated with critical habitat for listed species in a taxonomic grouping.

A qualitative versus quantitative risk assessment for sodium diacetate was chosen based on two premises: 1) the “generally regarded as safe – GRAS” food safety designation as assigned by the Food and Drug Administration (21 CFR 184.1005); and 2) the absence of sodium diacetate toxicity data.

Problem Formulation

Nature of Regulatory Action

Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), all pesticides distributed or sold in the United States generally must be registered by the United States Environmental Protection Agency (USEPA). To determine whether a pesticide can be registered, the USEPA evaluates its safety to non-target species based on a wide range of environmental and health effects studies. In 1996, FIFRA was amended by the Food Quality Protection Act (FQPA), and EPA was mandated to implement a new program for the periodic review of pesticides – registration review[1]. The registration review program is intended to ensure that, as the ability to assess risk evolves and as policies and practices change, all registered pesticides continue to meet the statutory standard of no unreasonable adverse effects to human health and the environment. Changes in science, public policy, and pesticide use practices will occur over time. Through the new registration review program, the Agency periodically reevaluates pesticides to make sure that as change occurs, products in the marketplace can be used safely.

Previous Assessments

Sodium diacetate was assessed previously in the Reregistration Eligibility Document (USEPA 1991). This document determined that the general knowledge of sodium diacetate’s use pattern and chemistry were sufficient to make environmental assessments. More specifically, the

[1] http://www.epa.gov/oppsrrd1/registration_review/

document highlighted that sodium diacetate is applied to post-harvest livestock feed crops that are primarily within farm facilities with limited environmental exposure. Exposure to aquatic environments from runoff events, if they occur, will only result in a short-term change to the pH that will be counteracted by the natural buffering capacity of the water. A 10 percent acetic acid solution would be needed to change the pH to 4.5 from 5.0, which is unlikely, given the use pattern. Sodium diacetate is the conjugate base of a weak acid, thus it is expected that the pH would remain relatively constant in a buffer solution of sodium acetate and acetic acid. Furthermore, sodium diacetate and its degradates are known to have low toxicity and are part of the normal function in metabolic pathways of animals (FASEB 1977). Thus, the risk to wildlife is deemed low.

Acetic acid, a major degradate, was assessed by the Biopesticide and Pollution Prevention Division (BPPD) (USEPA 2010, D367372) in 2010. Two products were considered – an 8 percent acetic acid solution and a 20 percent acetic acid solution. The assessment indicated possible risk to birds, insects, and terrestrial plants at an application rate of 29.4 lb ai/A, four applications per season.

No other risk assessments were identified.

Stressor Description

Sodium diacetate is a sodium acid salt of acetic acid, which readily dissociates into acetic acid and sodium acetate in the presence of moisture. Acetic acid is the active moiety of sodium diacetate, which acts as a fungicide and a bactericide to control molds and bacteria by temporarily changing the local acidity. It dissociates into acetate, sodium, and hydrogen ions. The ions that are produced by the dissociation of the sodium diacetate molecule are normal components of plants, animals, and human foods.

Acetates are common metabolic intermediates in living organisms and are formed during the metabolism of food substances. In particular, acetic acid is an integral part of the tricarboxylic acid cycle (Kreb’s cycle) and forms ATP for energy use in cells. Acetates and acetic acid have long been used safely without major adverse effects in both human and animal foods at moderate levels of consumption (FASEB 1997). The Food and Drug Administration lists acetic acid as a substance that is “generally recognized as safe” (GRAS) for use in food (21 CFR 184.1005). Acetic acid is commonly used for curing and pickling, flavoring, pH control, as a solvent vehicle, and boiler water additive. It is used in concentrations of up to 9% in relishes and condiments.

There are only two active registrations for sodium diacetate – Crop Cure and Crop Cure 2 – both registered by Domain, Inc. for post-harvest use on hay and silage (Table 3). It is applied to hay (stored in bales) to prevent spoilage, to silage as an aid in fermentation, and to preserve the quality of animal feeds such as field corn, alfalfa, sorghum, oats, and grasses that are stored in silos. It is also registered for use as a supplement to livestock/poultry feeds and dairy rations. Acetic acid is registered as an herbicide (e.g., registration numbers 8655-11, 69836-1, 81936-1) and is being assessed separately by the Biopesticides and Pollution Prevention Division (BPPD). There are no active registrations for sodium acetate.

Use Characteristics and Methods of Application

Sodium diacetate is used for the preservation of baled hay (alfalfa, brome grass, clover, orchard grass, and timothy) that is to be stored for animal feed. Sodium diacetate prevents the spoilage of baled hay by inhibiting the growth of mold and microbes. It is also an aid for silage fermentation (processed corn, hay, sorghum, oat, and grass silages) and an additive to improve the palatability of livestock feeds. Treated silage may only be fed to livestock and poultry.

Sodium diacetate can be applied in either a liquid or solid form. For hay preservation, solid-form sodium diacetate is applied to uniformly cover the hay during the baling process using a Gandy applicator (mechanism for evenly applying granules to hay or other commodities). For liquid applications, the sodium diacetate is diluted with water where it dissociates to form acetic acid. It should be uniformly applied at the time of baling using a pumping system with corrosion resistant parts. Application rates of sodium diacetate are dependent on hay moisture content; sodium diacetate should only be applied to hay with 15 to 25 percent moisture content.

As a livestock and poultry feed additive, sodium diacetate is mixed into the feed using a grinder/mixer. To achieve the appropriate mixture, grains (corn, soybean, wheat, barley, oats, etc.) and other dry ingredients (pre-mix diet supplements, vitamins, minerals, etc.) are first mixed together followed by the appropriate amount of sodium diacetate. After mixing well, high moisture ingredients (liquid vitamins, molasses, etc.) are incorporated; insufficient mixing may produce inconsistent mold inhibition. Sodium diacetate application rates are dependent upon the moisture content of the feed and should be applied to feeds containing 15 to 30 percent moisture.

As an aid in silage fermentation, sodium diacetate can be applied either as a solid or a liquid. For solid applications, a Gandy applicator (or equivalent) should be used to apply sodium diacetate at the time of chopping or at the blower when the silage is being loaded into the silo. The timing for liquid applications is the same, but a liquid applicator should be used. Application rates of sodium diacetate are dependent on silage moisture content (Tables 4 and 5). For corn, hay, grass, oat, and sorghum silage, the moisture content should be 50 to 70 percent; for high moisture ensiled corn, the moisture content should be 25 to 35 percent.

As an additive to dairy rations, sodium diacetate can be mixed into the feed or offered as a top dressing. When mixed into the feed, sodium diacetate is added after the other dry ingredients, but before the high moisture ingredients. When applied as a top dressing, it is sprinkled over the feed shortly before offering to livestock.

Table 3. Current sodium diacetate registrations

Registration Name (Registration Number)	Company	Active Ingredient	Uses
Crop Cure (32240-2)	Domain, Inc.	50%	Preservation of baled hay (alfalfa, brome grass, clover, orchard grass, and timothy) to be stored for the feeding season
Crop Cure 2 (32240-6)	Domain, Inc.	80%	For the preservation of baled hay (alfalfa, brome grass, clover, orchard grass, and Timothy) to be stored for the feeding season; improvement of palatability in livestock feeds (beef, swine, poultry, dairy cows); and aid in silage (processed corn, hay, sorghum, oat, and grass) fermentation

Table 4. Listing of label uses, application rates, form and equipment for sodium diacetate

Use Site	Max. Rate per Application (Registration Number)	Number of Applications	Form	Application Equipment/Type
Hay – alfalfa, brome grass, clover, orchard grass, and timothy	2 lb ai/ton of hay (liquid) (32240-6) 2.5 lb ai/ton of hay (solid) (32240-2)	Single application	Liquid or solid	Pumping system (liquid) Gandy applicator (solid)
Ground feeds – corn soybean, wheat, barley, oats, etc. (beef, swine, and poultry feeds)	3 lb ai/ton of feed (32240-2)	Single application	Solid	Livestock feed mixer/grinder
Silage fermentation – corn, hay, sorghum, oat, grass	3 lb ai/ton of silage (32240-2)	Single application	Liquid or solid	Liquid applicator (liquid) Gandy applicator (solid)
Dairy ration – corn, soybean, wheat, barley, oats, etc.	2 lb ai/ton of feed (32240-2)	Single application	Solid	Mix in feed or top dressing to feed

The Biological and Economic Analysis Division (BEAD) did not have up-to-date usage information (Screening Level Usage Estimates of Agricultural Uses – SLUA) for sodium diacetate. Detailed information about the uses was provided following a screening of the labels in 2007. The labels have not undergone any changes in 5 years and the information is still relevant (Table 5).

Table 5. Label information for sodium diacetate

Use site	Max. rate per app.	Feed type	Form	Application type
Alfalfa	0.1250 lb/cwt	Terrestrial feed crop	Form not identified/solid Soluble concentrate/solid	Spray/stored commodity non-fumigation
Clover	0.1250 lb/cwt	Terrestrial feed crop	Form not identified/solid Soluble concentrate/solid	Spray/stored commodity non-fumigation
Corn (processed/ground)	0.5000 gal/ton	Indoor food	Soluble concentrate/solid	Stored commodity non-fumigation
	2 lb/ton		Form not identified/solid	
Dairy animal feed (processed)	0.0156 lb/animal	Indoor food	Soluble concentrate/solid	Top dressing
	3 lb/ton			Stored commodity non-fumigation
Grass forage/fodder/hay	0.0250 gal/cwt	Terrestrial feed crop	Soluble concentrate/solid	Stored commodity non-fumigation
	0.1250 lb/cwt		Form not identified/solid Soluble concentrate/solid	Spray/stored commodity non-fumigation
Hay (silage)	0.0250 gal/cwt	Terrestrial feed crop	Soluble concentrate/solid	Stored commodity non-fumigation
	0.0500 lb/cwt		Form not identified/solid	
Livestock feed (processed)	3 lb/ton	Indoor food	Soluble concentrate/solid	Stored commodity non-fumigation
Oats (processed)	0.5000 gal/ton	Indoor food	Soluble concentrate/solid	Stored commodity non-fumigation
	1 lb/ton		Form not identified/solid	
Poultry feed (processed)	3 lb/ton	Indoor food	Soluble concentrate/solid	Stored commodity non-

Use site	Max. rate per app.	Feed type	Form	Application type
				fumigation
Sorghum (unspecified)	0.0250 gal/cwt	Terrestrial feed crop	Soluble concentrate/solid	Stored commodity non-fumigation
	0.0500 lb/cwt	Indoor food	Form not identified/solid	
Timothy	0.1250 lb/cwt	Terrestrial feed crop	Form not identified/solid Soluble concentrate/solid	Spray/stored commodity non-fumigation
Abbreviations: cwt = hundred weight				

Modifications to Registered Labels

There have been no substantial modifications to registered labels since the Problem Formulation was written (USEPA 2008, DP 344770).

Ecosystems Potentially at Risk

The registered uses of sodium diacetate are either indoor uses or outdoor uses that are isolated and relatively contained. For the feed fermentation and dairy ration uses, applications usually occur indoors or directly at the site of the silo. All treated feed that is used for livestock and poultry has the potential to be placed in the troughs of outdoor feedlots, but given the domestic surroundings (*e.g.,* farm buildings, farm house, animal houses), it is unlikely to come into contact with many non-target species; listed species are unlikely to venture into such developed areas.

For baled hay treatments that occur on the field, the risk of exposure from runoff is low; very high concentrations of acetic acid (major degradate) would be necessary to change the pH of an aquatic system and thus cause toxic responses. Incidental acute exposure to terrestrial wildlife using the bales of hay as a resource is also low, given the short half life (the estimated half-life of acetic acid is approximately 17.3 days in soil and 8.7 days in water). In addition, the available toxicity data for sodium diacetate, sodium acetate, and acetic acid indicate that these chemicals are practically non-toxic to mammals and slightly toxic to practically non-toxic to aquatic species. Given that exposure is expected to be negligible for both aquatic and terrestrial systems, it is not expected that the registered uses of sodium diacetate would pose any risk to threatened or endangered species.

Risk Hypothesis

For sodium diacetate, the following ecological risk hypothesis is being tested:

- Based on a qualitative review of the available information indicating negligible exposure to the terrestrial and aquatic environment, sodium diacetate will not pose an adverse risk to non-target terrestrial and aquatic organisms.

Analysis Plan

In Registration Review, pesticide ecological risk assessments will follow the Agency's Guidelines for Ecological Risk Assessment and will be in compliance with the paper entitled, "Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs, U. S. Environmental Protection Agency" (USEPA 2004).

The focus of an ecological risk assessment is on both the toxic effects of a pesticide to non-target organisms and the potential routes of the pesticide's exposure to non-target organisms. In addition to addressing a pesticide's toxic effects and potential routes of exposure, an ecological risk assessment addresses the uncertainties associated with a pesticide's risk to non-target organisms.

Consistent with the Agency's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to federally-listed threatened and/or endangered (listed) species from registered uses of sodium diacetate. This assessment will be conducted in accordance with the Overview Document (USEPA 2004), provisions of the ESA, and the Services' *Endangered Species Consultation Handbook* (US FWS/NMFS 1998).

In the case of a nationwide risk assessment conducted under registration review, the action area will encompass the entire U.S. and its territories. The purpose of defining the action areas as the entire U.S. and its territories is to ensure that the initial area of consideration encompasses all areas where the pesticide may be used now and in the future, including the potential for off-site transport via spray drift and downstream dilution. Additionally, the concept of a nationwide action area takes into account the potential for direct and indirect effects and any potential modification to critical habitat based on measured ecological effects that are associated with a reduction in survival, growth, and reproduction, as well as the full suite of sub-lethal effects available in the effects literature.

It is important to note that the nationwide action area does not imply that direct and/or indirect effects and critical habitat modification are expected to or are likely to occur over the full extent of the action area, but rather to identify all listed species and critical habitat that may potentially be affected by the action. The Agency will use more rigorous analyses, including consideration of available land cover data, toxicity data, and exposure information, to determine areas where individual listed species and designated critical habitat may be affected or modified via endpoints associated with reduced survival, growth, or reproduction.

Since exposure to non-target organisms from sodium diacetate use is expected to be negligible, no aquatic or terrestrial ecosystem is expected to be potentially at risk from registered uses of sodium diacetate. Therefore, a quantitative risk assessment will not be performed, but rather risk to terrestrial and aquatic organisms will be qualitatively assessed, in which no estimated environmental concentrations (EECs) or risk quotient (RQ) values will be generated.

Summary of Environmental Fate

The environmental fate of sodium diacetate and its two major degradates, acetic acid and sodium acetate, is well known. Environmental loadings are attributable to natural (plants and animal materials) and anthropogenic (food additives, drugs, and related products) sources. In water, sodium diacetate dissociates into an acetic acid-sodium acetate solution. The decomposition of these two compounds is very well established in the chemical and biological literature. Acetic acid decomposes directly into CO_2 and water. Acetic acid combines with metallic ions derived from other compounds in the soil to form acetate salts such as sodium acetate. In solution, sodium acetate produces sodium cations and acetate anions. The sodium cations may combine with other reactive materials in the soil. Acetate sorption is faster than its microbial uptake and utilization (Fisher and Kuzyakov 2010). The acetate anions will decompose to CO_2 and ethane. CO_2 is a common constituent of the atmosphere while ethane is a minor constituent in the atmosphere in many areas. Anions of the compounds undergo aerobically mediated mineralization in days to weeks, and completely degrade into CO_2 and water. A recent study shows, at a concentration of 10 µmol/L, the acetate anion has a half-life of about 3 minutes in soil solution and the oxidation to CO_2 is at a similar rate for the carbon atoms of both the $–CH_3$ and –COOH groups. However, the decomposition to CO_2 for carbon from $–CH_3$ decreased more strongly than carbon from –COOH at acetate concentrations that were greater than 100 µmol/L (Fisher and Kuzyakov 2010). Appendix A shows the complete degradation pathways of sodium diacetate and its metabolites.

Mobility of sodium diacetate, acetic acid, and sodium acetate is expected to be high, based on adsorption estimates (Koc = 1 ml/g, EPI 4.1). However, migration to ground water should be substantially mediated through biodegradation, volatilization, hydrolysis or through uptake and utilization within plant cells. Terrestrial organisms may be potentially exposed to acetic acid vapor following a rain event, as suggested by the high vapor pressure of acetic acid (15.7 mm Hg). With a pKa at 4.74, acetic acid will exist almost entirely in the ionized form at pH 5 – 9 and therefore, volatilization from the moist soil surfaces may not be an important fate process (TOXNET). The toxicity of sodium diacetate and acetic acid is driven by the acetate anion with the cations playing a minor role. Sodium diacetate and acetic acid are not persistent in the environment based on the predicted value (Table 6).

Table 6. Environmental fate of acetic acid (major degradate)

Parameter	Value	Reference
Hydrolysis	8.7 days	EPI Suite (v 4.10)
Aqueous Photolysis (t1/2)	17.2 days	EPI Suite (v 4.10)
Aerobic Soil Metabolism (t1/2)	17.3 days	EPI Suite (v 4.10)
Anaerobic Aquatic Metabolism (t1/2)	77.9 days	EPI Suite (v 4.10)

Effects to Organisms

Few sodium diacetate toxicity studies are available for non-target organisms. Given that the compound dissolves in water to become acetic acid and sodium acetate, EFED reviewed the effects of these degradates to non-target organisms. Data for sodium diacetate, sodium acetate, and acetic acid indicate these substances to be slightly toxic to practically non-toxic on an acute basis. Given that the exposure is expected to be negligible, it is unlikely that there would be any adverse effects to non-target organisms. The following is the summary of EFED's review.

AQUATIC EFFECTS

Aquatic exposure to sodium diacetate and its degradates is expected to be negligible. While sodium diacetate runoff may occur in the form of its degradate, acetic acid (formed via hydrolysis), it is unlikely that the weak acid will significantly alter the pH of an aquatic system or pose a potential hazard because of its short half-life (approximately 17.3 days in soil and 8.7 days in water).

No sodium diacetate toxicity studies are available for aquatic organisms, given that the compound dissociates, instantaneously into an acetic acid and sodium acetate solution; however, several submitted and open literature studies on the degradates have provided information.

Fish and Aquatic Invertebrates

An acetic acid acute toxicity study on *Daphnia magna* reported a 48-h EC_{50} as 65 ± 9.0 mg ai/L, classifying acetic acid as slightly toxic to freshwater invertebrates (MRID 48770802).

A second study examined the acute effects of acetic acid on several freshwater species: tilapia (*Oreochromis mossambicus*), a cladoceran (*Moina micrura*), and an oligochaete worm (*Branchiura sowerbyi*) (MRID 48770801). A 96-h LC_{50} and confidence interval are listed in Table 7 for each species. Fish exhibited whitish lesions on their skin and fins after a few hours of exposure to concentrations of 262.4 mg ai/L and higher. They also showed signs of respiratory distress (frequent surfacing, abnormal opercular movement, gasping, release of air bubbles from mouth, and loss of equilibrium). The oligochaete worms reacted by sharply coiling their bodies at the higher concentrations of acetic acid (the study was not specific about which concentrations). Their bodies gradually fragmented, resulting in death. Cladocerans were observed to exhibit decreased swimming activity before death.

Table 7. LC_{50} for freshwater fish, cladoceran, and worm exposed to acetic acid for 96 hours

	LC_{50} and Confidence Interval (mg ai/L)
Fish	272.87 (268.99-276.75)
Cladoceran	163.72 (156.38-171.07)
Worm	14.90 (14.48-15.43)

The chronic effects of acetic acid on tilapia were examined in a 90-day outdoor study (MRID 48770801). No mortality occurred during the test. There were significant differences between the control and various treatment levels for the following: food consumption, food conversion efficiency, specific growth rate, yield, percent increase in weight, fecundity, and maturity index. Table 8 provides the NOAEC values for the various parameters that were measured.

Table 8. NOAECs values for multiple parameters of freshwater tilapia fish exposed to acetic acid for 90 days

	NOAEC (mg ai/L)
Food consumption	1.26
Food conversion efficiency	1.47
Specific growth rate	1.47
Yield	1.47
Percent increase in weight	1.47
Fecundity	1.47
Male maturity index	1.26
Female maturity index	16.79

Cairns et al. (1976) conducted a study to measure the 48-h acute effects of acetic acid on two freshwater snail species (*Goniobasis livescens* and *Lymnaea emarginata angulata*) (Table 9). A limitation of the study is that the lake water used in the experiment was not tested to confirm the absence of additional contaminants, although the control performance was deemed normal. Furthermore, the Agency's normal endpoint for acute toxicity effects on mollusks is 96 hours (a more conservative value) rather than 48 hours.

Table 9. 48-h acute toxicity values for two species of freshwater snail exposed to acetic acid

	48-h LC_{50} (mg ai/L)
Goniobasis livescens	460
Lymnaea emarginata angulata	320

Locke et al. (2009) documented the acute effects of acetic acid to two estuarine/marine species: threespine stickleback fish (*Gasterosteus acucleatus*) and the sand shrimp (*Crangon septemspinosa*) (Table 10). The results of this study should be interpreted with caution as the dose-response curves were very steep for both organisms (fish – 0% morality at 0, 32, and 100 mg ai/L but 100% mortality at ≥320mg ai/L; shrimp – 0% mortality at 0, 5, and 500 mg ai/L, but 100% mortality at ≥ 500 mg ai/L).

Table 10. Toxicity values for the threespine stickleback fish and the sand shrimp

	96-h LC_{50} (mg ai/L)	96-h NOAEC (mg ai/L)
Threespine stickleback fish	178	100
Sand shrimp	158	50

Piola *et al.* (2010) tested the effectiveness of a 5% acetic acid solution (52,450 mg ai/L) to manage tunicates, algae, tubeworm, bryozoans, and other fouling organisms. This experiment demonstrated that acetic acid can be detrimental to marine/estuarine organisms at high concentrations. Likewise, Paetzold *et al.* (2008) reported the effects of 5% acetic acid on estuarine/marine amphipods and gastropods. The study showed that amphipods were much more sensitive to the concentrated acetic acid exposures than the gastropods. All of the amphipods were classified as "inactive" after 5 minutes and 90% of them were dead after 2-3 hours. In contrast, 70% of the gastropods were classified as "inactive" at the 5 minute observation period, but most had completely recovered by the 5 to 9 day observation period. The Agency concludes that high acetic acid concentrations (5%) are unlikely to be present in aquatic systems through runoff from the registered uses of sodium diacetate.

Aquatic Plants

BPPD used an algal (*Scenedesmus quadricanda*) toxicity threshold of 4000 mg ai/L in their risk assessment of acetic acid (USEPA 2010). Two studies were available that documented the effects of acetic acid on aquatic plants. Table 11 shows the effects of acetic acid on the re-growth of hydrilla (*Hydrilla verticillata*); the most sensitive IC_{50} is for dry weight at 549 mg ai/L (MRID 48770803). Academy of Natural Sciences (1960) reported the effects of acetic acid on freshwater diatoms (*Navicula seminulum var. hustedtii*) with a 120-h LC_{50} of 74 ppm.

Table 11. The effect of acetic acid on hydrilla

Characteristic	**IC_{50} (mg ai/L)**
Shoot length	851
New shoots	675
Dry weight	549

TERRESTRIAL EFFECTS

Terrestrial exposure to sodium diacetate and its degradates is expected to be negligible. Several sodium diacetate applications occur in feed grinders/mixers, which are contained and usually located indoors. One use involves the application of sodium diacetate to silage as the grains are being loaded into the silos. The application is expected to occur in built-up areas of the farm resulting in low potential exposure to non-target species. The most likely environmental exposure pathway is through applications to hay during the baling process on the field. However, given the short half-life and practically non-toxic classification, it is unlikely that a non-target organism will be adversely affected.

Birds, Reptiles, and Land-phase Amphibians

In a chronic avian toxicity study, turkey poults (50 days old) were exposed to sodium acetate in drinking water for 7 weeks (Adams et al. 1969). No mortalities occurred, but enlarged kidneys were observed in the sodium acetate treatment group at 6178 ppm. Therefore, a LOEL of 6178 ppm was established for sodium acetate. Adjusting for sodium diacetate (two acetates for every sodium), the LOEL is 3089 ppm.

Data were not available for reptiles or land-phase amphibians; thus, birds are used as a surrogate for these groups.

Mammals

A registrant-submitted rat acute oral toxicity study for sodium diacetate reported an oral LD_{50} of 5600 mg ai/kg (USEPA 2008). This endpoint classifies sodium diacetate as practically non-toxic to mammals. Several other rat studies were available from the human health effects risk assessment in the RED (USEPA 1991). The dermal LD_{50} was reported as > 2000 mg ai/kg. An 8-h inhalation study induced a slight petechial hemorrhage in the lungs. Sodium diacetate is an eye irritant, which is expected because of its dissociation into acetic acid (a weak acid) when coming into contact with water. An eye irritation study in rabbits induced chemosis and redness and another rabbit study documented severe corneal necrosis with a 15% solution, but only trace injuries with a 5% solution. There was no dermal irritation on rabbits using a 50% solution.

A chronic study for the effects of sodium acetate (a degradate of sodium diacetate) on mice was available from the open literature (Kavlock et al. 1987). The study monitored pregnant mice, specifically maternal weight change and mortality, and neonatal weight change and mortality. No effects (including sub-lethal) were found at the limit dose tested, thus establishing a NOAEC of 1000 mg ai/kg-day for sodium acetate. Table 12 provides the mammalian toxicity summary for sodium diacetate and sodium acetate. Given that sodium diacetate contains two acetate molecules for each sodium ion, the estimated NOAEC for sodium diacetate is 500 mg ai/kg-day.

Table 12. Mammal toxicity information for sodium diacetate and sodium acetate

Toxicity Route	Value
Sodium Diacetate	
Acute oral	5600 mg ai/kg
Acute dermal	> 2000 mg ai/kg
Acute inhalation	Not determined
Eye irritation	Corneal involvement clearing in 8-21 days
Dermal irritation	No irritation
Skin sensitizer	Not determined
Sodium Acetate	
Chronic reproductive (NOAEC)	1000 mg ai/kg-day

The metabolic pathways in mammals for sodium diacetate, acetic acid, and acetate were documented. Acetic acid is readily absorbed from the gastrointestinal tract and from the lungs (FASEB 1977, Clayton and Clayton 1982). It is rapidly and naturally incorporated into the intermediary metabolism by most tissues of the body (Clayton and Clayton 1982). Acetate is completely utilized in oxidative metabolism or in anabolic syntheses. Isotope experiments have shown acetate to be used in the formation of glycogen, carbohydrate intermediates, phospholipids, and fatty acids, as well as in cholesterol and steroid synthesis (Clayton and Clayton 1982, Geigy 1970, FASEB 1977). In addition, it participates in the acetylation of the amines and may be converted to alanine by transamination and then incorporated into proteins of the plasma, liver, kidney, gut mucosa, muscle, and brain (Geigy 1970). It has been estimated that the rat forms acetate at the rate of one percent of its body weight per day (FASEB 1977).

Terrestrial Invertebrates

van Engelsdorp *et al.* 2008, tested the effectiveness of acetic acid as a fumigant to control *varroa* mites in honey bee colonies. *Varroa* mites are a parasite and can greatly reduce honey bee colony size and productivity. Each hive was treated with 26,225 mg of acetic acid (50 mL of a 50% acetic acid solution). No bee or *varroa* mite mortality was found in the hives treated with acetic acid. This experiment indicates that acetic acid is relatively non-toxic to terrestrial invertebrates.

Terrestrial Plants

Information is not available regarding the effects of sodium diacetate on terrestrial plants; likewise, information is limited for acetic acid's effects. Acetic acid is registered as a non-selective herbicide by OPP. The most recent risk assessment for acetic acid (USEPA 2010, DP 367372) describes the mode of action in plants as the disruption of the cuticle on the surface of plant leaves and stem, which results in a rapid desiccation and browning of the plant. The assessment indicates that to be efficacious, plants must be thoroughly drenched with the products (20% and 8% acetic acid) for effective control to occur. A rate of 29.4 lb ai/A/application, four applications per year was assessed. This resulted in potential risks to non-target birds, terrestrial insects, and plants. However, the application rates are far higher than the registered uses for sodium diacetate, making it unlikely that such risks would be present for sodium diacetate applications. Stopar (2008) reported phytotoxic effects in apple trees as a result of acetic acid applications for apple blossom thinning. The most common effects were the burning of leaf edges and partially stunted growth of young leaves; effects appeared a few days after spraying and lingered for 11 weeks. The effects were most pronounced at the 525 mg ai/L treatment level.

Incident Database Review

On February 23, 2012, a review of the Ecological Incident Information System (EISS, version 2.1.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Monitoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicated no incident reports for sodium diacetate and its major degradates – acetic acid and sodium acetate. In addition to the incidents recorded in EIIS, other incidents may have been reported to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as "minor fish and wildlife" (W-B), "minor plant" (P-B), and "other non-target" (ONT) incidents. "Other non-target" incidents include reports of adverse effects to insects and other terrestrial invertebrates. For sodium diacetate and its degradates, no incidents were contained in this database.

Risk to Non-Listed and Listed Species

Direct adverse effects based on survival, growth, and reproduction to terrestrial and aquatic non-listed species from the use of sodium diacetate are not expected (Table 13). This is based on several lines of evidence:

- The registered uses of sodium diacetate are limited to either indoor uses or outdoor uses that are isolated and relatively contained. For the feed fermentation and dairy ration uses, applications usually occur indoors or directly at the site of the silo. All treated feed that is used for livestock and poultry has the potential to be placed in the troughs of outdoor feedlots, but given the domestic surroundings (*e.g.*, farm buildings, farm house, animal houses), it is unlikely to come into contact with many non-target species; listed species are unlikely to venture into such developed areas. For baled hay treatments that occur on the field, the risk of exposure from runoff is low; very high concentrations of acetic acid (major degradate) would be necessary to change the pH of an aquatic system and cause toxic responses. Other terrestrial wildlife exposures via incidental use of baled hay in a field would also likely be limited and not result in the consumption of concentrations high enough to cause an acute toxic response. Therefore, the anticipated environmental concentrations for sodium diacetate are expected to be below levels that could be of toxicological significance to non-target terrestrial and aquatic organisms.

- The available toxicity data for sodium diacetate and its degradates – sodium acetate and acetic acid – indicate that these chemicals are practically non-toxic to mammals on an acute basis and slightly toxic to practically non-toxic to aquatic species. For terrestrial plants, acetic acid can cause phytotoxic damage (Stopar 2008), if applied in high enough concentrations (8-20%) and amounts (e.g., drenching the plant leaves). The amount of acetic acid that might be expected in runoff waters is lower and probably would not result in "drenching" the entire plant, thus avoiding any major effects. There is evidence that should phytotoxic damage occur, recovery would take place within 2 months of the exposure (Stopar 2008). Barring repeated acetic acid drenches, it is unlikely that there would be any long-lasting effects to non-target terrestrial plants. Toxicity data for aquatic plants indicate that some plants are more sensitive than others (diatoms versus algae); however, it is unlikely that high enough concentrations of acetic acid would concentrate in a water body to cause a toxic response. Therefore, even if terrestrial and/or aquatic species were to come into contact with sodium diacetate-treated grain, hay, or runoff water, direct exposure to it and its degradates at levels expected to cause effects would be unlikely, based on its low toxicity and its degradation properties.

- Sodium diacetate dissociates into sodium acetate and acetic acid upon the addition of water. The half-life of acetic acid is approximately 17.3 days in soil and 8.7 days in water, indicating that the degradation is rapid. Acetic acid also is a normal component of metabolism in the human body and many other organisms. It plays an integral role in producing ATP during the Kreb's cycle. Thus, it is not expected to adversely affect non-target species.

Overall, the use of sodium diacetate is expected to have no effect to non-listed and listed terrestrial and aquatic organisms, based on survival, growth, and reproduction.

Indirect Effects to Listed Species

Since direct adverse effects are not expected for listed species based on survival, growth, and reproduction, indirect effects to terrestrial and aquatic listed species also are not expected.

Effects to Critical Habitat

No adverse modifications to critical habitat for any terrestrial or aquatic listed species are expected from the use of sodium diacetate. This is based on the same lines of evidence as presented above.

Table 13. Potential risks to non-listed and listed species associated with direct or indirect effects from the proposed application of sodium diacetate

Taxonomic Group	Effects Endpoint[1]	Direct Effects[2]		Indirect Effects to Listed Species	
		Non-Listed	Listed	Potential	Indirect Effects from Direct Effect to:[3]
Aquatic vascular plants	Measures of biomass	No	No	No	Not applicable
Aquatic non-vascular plants	Measures of biomass	No	No	No	Not applicable
Terrestrial plants	Measures of biomass-NA[4]	No	No	No	Not applicable
Freshwater vertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Estuarine/marine vertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Freshwater invertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Estuarine/marine invertebrates	Acute: mortality Chronic: NOAEC growth & reproduction-NA	No	No	No	Not applicable
Mammals	Acute oral dose: mortality Sub-acute dietary: mortality and growth-NA Chronic: growth and reproduction-NA	No	No	No	Not applicable
Birds	Acute oral dose: mortality-NA Sub-acute dietary: mortality and growth Chronic: growth and reproduction-NA	No	No	No	Not applicable
Terrestrial invertebrates	Acute contact and oral: mortality	No	No	No	Not applicable

[1]Abbreviations: NA = toxicity data not available
[2]Negligible exposures to non-target organisms from sodium diacetate registered uses being indoors or contained (no spray drift, runoff, spillage). Therefore, adverse effects are not expected.
[3]Direct effects to species may result in indirect effects to other species by changing availability of prey, habitat, and other factors important to survival and reproduction.
[4]Acetic acid is registered as a non-selective herbicide, so it is expected that if directly applied to non-target plants, there could be adverse effects; however, the usage on hay/silage/feed is not expected to come into contact with non-target plants.

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Anderson, B. G. (1944). The Toxicity Thresholds of Various Substances Found in Industrial Wastes as Determined by the Use of Daphnia magna. *Sewage Works J.* 16: 1156-1165.

EcoReference No.: 2171
Chemical of Concern: ACAC,AN,AlCl,AlKS,AlS,As,AsO4Na,BZO,Ba,CIT,CaCl2,CoCl,CrO4,CuCl,CuS,ETHN,FeCl,FeCl3,FeRS,HCL,Halides,K2Cr2O7,KCl,KPM,LLA,MOL,NHCl,NHOH,NHSO4,NaCBN,NaCO,NaCl,NaNO3,NaOH,NaSO4,OXAC,PL,SAAAS,SUA,ZnS; Habitat: A; Effect Codes: PHY; Code: LITE EVAL CODED (ACAC,BZO,CIT,CaCl2,CrO4,ETHN,FeRS,HCL,Halides,MOL,NHOH,NaCl,NaNO3,NaOH,OXAC,SUA,ZnS), NO CONTROL (CuS), NO EFED CHEM (AN,AlCl,AlKS,AlS,AsO4Na,Ba,CoCl,FeCl,FeCl3,K2Cr2O7,KCl,KPM,NHCl,NHSO4,NaCBN,NaCO,NaSO4,PL,SAAAS), NO ENDPOINT (CuS), OK (As,CuCl,LLA).

Not the lowest endpoint, test duration was 16 hours instead of 48 hours.

Barry, J. D. and Polavarapu, S. (2004). Feeding Activity and Attraction of Blueberry Maggot (Diptera: Tephritidae) to Protein Baits, Ammonium Acetate, and Sucrose. *J. Econ. Entomol.* 97: 1269-1277.

EcoReference No.: 87498
Chemical of Concern: NHAC; Habitat: T; Effect Codes: BEH; Code: LITE EVAL CODED (NHAC).

Test duration was too short.

Begum, S. J., Mohanachari, V., and Indira, K. (1984). Changes in Energy Fuels of Fish During Ammonia Stress. *Environ. Ecol.* 2: 286-289.

EcoReference No.: 119
Chemical of Concern: NHAC; Habitat: A; Effect Codes: BCM,GRO; Code: LITE EVAL CODED (NHAC).

Test duration was not 96 hours.

Bodega, G., Suarez, I., Boyano, M. C., Rubio, M., Villalba, R. M., Arilla, E., Gonzalez-Guijarro, L., and Fernandez, B. (1993). High Ammonia Diet: Its Effect on the Glial Fibrillary Acidic Protein (GFAP). *Neurochem. Res.* 18: 971-975.

EcoReference No.: 151921
Chemical of Concern: NHAC; Habitat: T; Effect Codes: ACC,BCM,BEH,GRO; Code: LITE EVAL CODED (NHAC).

Endpoints were not reported in units useful for the risk assessment.

Boyano-Adanez, M. C., Bodega, G., Barrios, V., and Arilla, E. (1996). Response of Rat Cerebral Somatostatinergic System to a High Ammonia Diet. *Neurochem.Int.* 29: 469-476.

EcoReference No.: 113073
Chemical of Concern: NHAC; Habitat: T; Effect Codes: BCM,GRO; Code: LITE EVAL CODED (NHAC).

Endpoints were not reported in units useful for the risk assessment.

Corsi, S. R., Geis, S. W., Bowman, G., Failey, G. G., and Rutter, T. D. (2009). Aquatic Toxicity of Airfield-Pavement Deicer Materials and Implications for Airport Runoff. *Environ. Sci. Technol.* 43: 40-46.

EcoReference No.: 115482
Chemical of Concern: KACE; Habitat: A; Effect Codes: GRO,MOR,POP,REP; Code: LITE EVAL CODED (KACE).

Endpoint was not useful for the risk assessment.

Dabrowska, H. and Sikora, H. (1986). Acute Toxicity of Ammonia to Common Carp (Cyprinus carpio L.). *Pol. Arch. Hydrobiol.* 33: 121-128.

EcoReference No.: 12711
Chemical of Concern: NHAC,NHCl,NHN,NHOH,NHS; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED (NHAC,NHN,NHOH), NO EFED CHEM (NHCl,NHS).

Duration of the test was not 96 hours.

De Avila Fortes, M., Oliveira de Sousa, R., Schmidt, F., Costa de Oliveira, A., and Vahl, L. C. (2009). Calcium Effects on Acetic Acid Toxicity in Rice. *Commun. Soil Sci. Plant Anal.* 40: 2536-2544.

EcoReference No.: 151918
Chemical of Concern: ACAC; Habitat: A; Effect Codes: ACC,BCM,GRO; Code: LITE EVAL CODED (ACAC).

Endpoints were not reported in units useful for the risk assessment.

DeYoung, D. J., Bantle, J. A., Hull, M. A., and Burks, S. L. (1996). Differences in Sensitivity to Developmental Toxicants as seen in Xenopus and Pimephales Embryos. *Bull. Environ. Contam. Toxicol.* 56(1): 143-150.

EcoReference No.: 16432
Chemical of Concern: NACE; Habitat: A; Effect Codes: GRO,MOR; Code: LITE EVAL CODED (NACE).

The test was 120 hours in duration rather than 96 hours.

Dial, E. J., Hall, L. R., Romero, J. J., and Lichtenberger, L. M. (1996). Rats with Gastritis have Increased Sensitivity to the Gastrin Stimulatory Effects of Luminal Ammonia. *Gastroenterology* 110: 801-808.

EcoReference No.: 151841
Chemical of Concern: NHAC; Habitat: T; Effect Codes: BCM,BEH,CEL,GRO; Code: LITE EVAL CODED (NHAC).

Endpoints were not reported in units useful for the risk assessment.

Djian, C., Ponchet, M., and Cayrol, J. C. (1994). Nematocidal Properties of Carboxylic Acids and Derivatives. *Pestic. Biochem. Physiol.* 50: 229-239.

EcoReference No.: 96598
Chemical of Concern: ACAC,ADC,BZO,DBE,EP,FMA,GLYA,OXAC,PPA,SCA; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED (ACAC,ADC,BZO,EP,OXAC,PPA,SCA), NO EFED CHEM (DBE,FMA,GLYA).

Endpoints were not reported in units useful for the risk assessment.

Fort, D. J., McLaughlin, D. W., Rogers, R. L., and Buzzard, B. O. (2003). Evaluation of the

Developmental Toxicities of Ethanol, Acetaldehyde, and Thioacetamide Using FETAX. *Drug Chem. Toxicol. (N.Y.)* 26: 23-34.

EcoReference No.: 82000
Chemical of Concern: ACAC,ETHN,PCB; Habitat: A; Effect Codes: GRO,MOR; Code: LITE EVAL CODED (ACAC,ETHN), NO EFED CHEM (PCB), NO MIXTURE (PCB).

Study was evaluated, but classified as “invalid.”

Greer, L. and Dole, J. M. (2005). Defoliation of Woody Cut Stems with Preharvest, Less Toxic Chemical and Postharvest Environmental Methods. *HortTechnology* 15: 376-380.

EcoReference No.: 118123
Chemical of Concern: ACAC,DMP,EPH,NONA; Habitat: T; Effect Codes: CEL,PHY; Code: LITE EVAL CODED (ACAC,EPH,NONA), NO EFED CHEM (DMP).

Study was evaluated, but classified as “invalid.”

Heath, R. R., Epsky, N. D., Guzman, A., Dueben, B. D., Manukian, A., and Meyer, W. L. (1995). Development of a Dry Plastic Insect Trap with Food-Based Synthetic Attractant for the Mediterranean and Mexican Fruit Flies (Diptera: Tephritidae). *J. Econ. Entomol.* 88: 1307-1315.

EcoReference No.: 151926
Chemical of Concern: NHAC; Habitat: T; Effect Codes: BEH; Code: LITE EVAL CODED (NHAC).

Endpoints were not reported in units useful for the risk assessment.

Hernandez, C., Martin, M., Bodega, G., Suarez, I., Perez, J., and Fernandez, B. (1999). Response of Carp Central Nervous System to Hyperammonemic Conditions: An Immunocytochemical Study of Glutamine Synthetase (GS), Glial Fibrillary Acidic Protein (GFAP) and 70 kDa Heat-Shock Protein (HSP70). *Aquat. Toxicol.* 45(2-3): 195-207.

EcoReference No.: 19920
Chemical of Concern: NH,NHAC; Habitat: A; Effect Codes: BCM,MOR; Code: LITE EVAL CODED (NHAC), NO EFED CHEM (NH).

Endpoint was not useful for the risk assessment.

Hirazawa, N., Oshima, S. I., Hara, T., Mitsuboshi, T., and Hata, K. (2001). Antiparasitic Effect of Medium-Chain Fatty Acids Against the Ciliate Cryptocaryon irritans Infestation in the Red Sea Bream Pagrus major. *Aquaculture* 198: 219-228.

EcoReference No.: 105099
Chemical of Concern: ACAC,CAC,CRA,NONA; Habitat: A; Effect Codes:

MOR,PHY; Code: LITE EVAL CODED (ACAC,CAC,CRA,NONA).

Endpoint was not useful for the risk assessment.

Iishi, H., Tatsuta, M., Baba, M., Mikuni, T., Yamamoto, R., Iseki, K., Yano, H., Uehara, H., and Nakaizumi, A. (1997). Enhancement by Monochloramine of the Development of Gastric Cancers in Rats: a Possible Mechanism of Helicobacter pylori-Associated Gastric Carcinogenesis. *J. Gastroenterol.* 32: 435-441.

EcoReference No.: 151911
Chemical of Concern: NHAC,NaHCT; Habitat: T; Effect Codes: CEL,GRO,PHY; Code: LITE EVAL CODED (NHAC), NO EFED CHEM (NaHCT).

Endpoints were not reported in units useful to the risk assessment.

Insausti, A. M., Gaztelu, J. M., Gonzalo, L. M., Romero-Vives, M., Barrenechea, C., Felipo, V., and Insausti, R. (1997). Diet Induced Hyperammonemia Decreases Neuronal Nuclear Size in Rat Entorhinal Cortex . *Neurosci. Lett.* 231: 179-181.

EcoReference No.: 151927
Chemical of Concern: NHAC; Habitat: T; Effect Codes: CEL; Code: LITE EVAL CODED (NHAC).

Endpoint was not reported in units useful to the risk assessment.

Jester, J. V., Molai, A., Petroll, W. M., Parker, R. D., Carr, G. J., Cavanagh, H. D., and Maurer, J. K. (2000). Quantitative Characterization of Acid- and Alkali-Induced Corneal Injury in the Low-Volume Eye Test. *Toxicol. Pathol.* 28: 668-678.

EcoReference No.: 151823
Chemical of Concern: ACAC,NaOH; Habitat: T; Effect Codes: CEL,GRO,MOR,PHY; Code: LITE EVAL CODED (ACAC,NaOH).

Endpoints were not reported in units useful to the risk assessment.

Joseph, R. M., Devineni, A. V., King, I. F. G., and Heberlein, U. (2009). Oviposition Preference for and Positional Avoidance of Acetic Acid Provide a Model for Competing Behavioral Drives in Drosophila. *Proc. Natl. Acad. Sci. U.S.A.* 106: 11352-11357.

EcoReference No.: 151928
Chemical of Concern: ACAC,HCL,SUA; Habitat: T; Effect Codes: BEH,CEL,REP; Code: LITE EVAL CODED (ACAC,HCL,SUA), TARGET (HCL).

Duration of the experiment was not in accord with OPP Guidelines.

Kane, M. T. (1979). Fatty Acids as Energy Sources for Culture of One-Cell Rabbit Ova to Viable Morulae. *Biol. Reprod.* 20: 323-332.

EcoReference No.: 101665
Chemical of Concern: ACAC,OLEA,PPA; Habitat: T; Effect Codes: GRO; Code: LITE EVAL CODED (ACAC,PPA), NO EFED CHEM (OLEA).

Endpoint was not reported in units useful to the risk assessment.

Kavlock, R. J., Short, R. D. Jr., and Chernoff, N. (1987). Further Evaluation of an In Vivo Teratology Screen. *Teratog. Carcinog. Mutagen.* 7: 7-16.

EcoReference No.: 70488
Chemical of Concern: 24D,24DXY,BMY,CBL,CCA,DM,EN,MRX,Maneb,NACE,PNB,PPCP,PPGL,Zineb; Habitat: T; Effect Codes: GRO,MOR,REP; Code: LITE EVAL CODED (24D,24DXY,BMY,CBL,DM,Maneb,NACE,PNB), NO EFED CHEM (CCA,EN,MRX,PPCP,PPGL,Zineb).

Evaluated as “qualitative” and used in the risk assessment.

Kazumori, H., Ishihara, S., Fukuda, R., and Kinoshita, Y. (2002). Time-Course Changes of ECL Cell Markers in Acetic Acid-Induced Gastric Ulcers in Rats. *Aliment. Pharmacol. Ther.* 16: 10-19.

EcoReference No.: 103295
Chemical of Concern: ACAC; Habitat: T; Effect Codes: BCM,CEL; Code: LITE EVAL CODED (ACAC).

Endpoints were not reported in units that were useful to the risk assessment.

Locke, A., Doe, K. G., Fairchild, W. L., Jackman, P. M., and Reese, E. J. (2009). Preliminary Evaluation of Effects of Invasive Tunicate Management with Acetic Acid and Calcium Hydroxide on Non-Target Marine Organisms in Prince Edward Island, Canada. *Aquat. Invasions* 4: 221-236.

EcoReference No.: 115787
Chemical of Concern: ACAC,CIT,HCL; Habitat: A; Effect Codes: GRO,MOR; Code: LITE EVAL CODED (ACAC), NO BACTERIA (HCL), NO CONC (CIT).

Evaluated as “qualitative” and used in the risk assessment.

Lynch, J. M. (1980). Effects of Organic Acids on the Germination of Seeds and Growth of Seedlings. *Plant Cell Environ.* 3: 255-259.

EcoReference No.: 101602
Chemical of Concern: ACAC,BZO,CIT,CaCO3,FMA,LLA,PPA,SCA; Habitat: T; Effect Codes: ACC,GRO,REP; Code: LITE EVAL CODED (ACAC,BZO,CIT,LLA,PPA,SCA), NO EFED CHEM (CaCO3,FMA).

Endpoints were not reported in units useful to the risk assessment.

Mayer, D. F., Lunden, J. D., Kovacs, G., and Miliczky, E. R. (2001). Field Evaluation of Non-Pesticide Chemicals as Honey Bee Repellents. *In: L.P.Elzunces, C.Elissier, & G.B.Lewis (Eds.), Hazards of Pesticides to Bees, Institute National de la Recherche Agronomique, Paris, France* 159-168.

EcoReference No.: 81711
Chemical of Concern: 3-OCT,ACAC,ATC,BOR,BPRO,C6OH,C8OH,CAC,CASTOR,CBNDS,CF,CRA,CRV,CWO,CaCO3,Captan,DBAC,DIC,DMDS,DMZ,DNS,EGL,ETHB,FAR,FTTCl,H3PO4,HTS,IMC,IND,IPA,LIM,LIN,MAT,NCTN,OCRE,PCRE,PHTH,PL,PPCP,PPNOL,SFR,TML,nBUT; Habitat: T; Effect Codes: BEH; Code: LITE EVAL CODED (ACAC,BPRO,C8OH,CASTOR,CBNDS,CRA,CRV,CWO,Captan,DBAC,DMDS,DMZ,DNS,EGL,ETHB,FAR,FTTCl,H3PO4,HTS,IMC,IND,LIM,MAT,NCTN,OCRE,PPNOL,SFR,TML,nBUT), NO EFED CHEM (ATC,C6OH,CF,CaCO3,DIC,IPA,LIN,PHTH,PL,PPCP), NO EFFECT (BOR,CAC,PCRE,PL), NO MIXTURE (PHTH).

Duration of the experiment was not in accord with OPP Guidelines.

Mollet, P. (1976). Lack of Proof of Induction of Somatic Recombination and Mutation in Drosophila by Methyl-2- Benzimidazole Carbamate, Dimethyl Sulfoxide and Acetic Acid. *Mutat. Res.* 40: 383-388.

EcoReference No.: 104295
Chemical of Concern: ACAC,CBD; Habitat: T; Effect Codes: CEL,MOR; Code: LITE EVAL CODED (ACAC,CBD).

Duration of the experiment was not in accord with OPP Guidelines.

Paetzold, S. C., Davidson, J., and Giberson, D. (2008). Responses of Mitrella lunata and Caprella spp., Potential Tunicate Micropredators, in Prince Edward Island Estuaries to Acetic Acid Anti-Fouling Treatments. *Aquaculture* 285: 96-101.

EcoReference No.: 151824
Chemical of Concern: ACAC; Habitat: A; Effect Codes: BEH,MOR,POP; Code: LITE EVAL CODED (ACAC).

Evaluated as “qualitative” and used in the risk assessment.

Parkash, R. and Vandna (1994). Latitudinal Differentiation in Alcoholic Utilisation and Desiccation-Starvation Tolerance in Drosophila kikkawai Populations from India. *Korean J. Genet.* 16: 217-224.

EcoReference No.: 103292
Chemical of Concern: ACAC,ETHN,IPA,PPNOL,nBUT; Habitat: T; Effect Codes: MOR; Code: LITE EVAL CODED (ACAC,ETHN,PPNOL,nBUT), NO EFED CHEM (IPA).

Evaluated, but found to be “invalid.”

Pelacho, A. M., Martin-Closas, L., and Sanfeliu, J. L. I. (1999). In Vitro Induction of Potato Tuberization by Organic Acids. *Potato Res.* 42: 585-591.

EcoReference No.: 101664
Chemical of Concern: ACAC,HCL,PPA,SCA; Habitat: T; Effect Codes: GRO; Code: LITE EVAL CODED (ACAC,HCL,PPA,SCA).

Endpoints were not reported in units that were useful to the risk assessment.

Piola, R. F., Dunmore, R. A., and Forrest, B. M. (2010). Assessing the Efficacy of Spray-Delivered 'Eco-Friendly' Chemicals for the Control and Eradication of Marine Fouling Pests. *Biofouling* 26: 187-203.

EcoReference No.: 151917
Chemical of Concern: ACAC,NaHCT; Habitat: A; Effect Codes: MOR,POP; Code: LITE EVAL CODED (ACAC), NO EFED CHEM (NaHCT).

Evaluated as “qualitative” and used in the risk assessment.

Rao, D. N. and Mikkelsen, D. S. (1977). Effect of Acetic, Propionic, and Butyric Acids on Young Rice Seedlings' Growth. *Agron. J.* 69: 923-928.

EcoReference No.: 42791
Chemical of Concern: ACAC,PPA; Habitat: T; Effect Codes: GRO; Code: LITE EVAL CODED (ACAC,PPA).

Endpoints were not reported in units that were useful to the risk assessment.

Rotstein, J. B. and Slaga, T. J. (1988). Acetic Acid, a Potent Agent of Tumor Progression in the Multistage Mouse Skin Model for Chemical Carcinogenesis. *Cancer Lett.* 42: 87-90.

EcoReference No.: 103294
Chemical of Concern: ACAC; Habitat: T; Effect Codes: CEL,MOR,PHY; Code: LITE EVAL CODED (ACAC).

Endpoint was not reported in units useful to the risk assessment.

Sashikala, R., Krishna Mohan, P., and Indira, K. (1985). Protein Degradation and Transamination Patterns in a Fresh Water Fish Under Ambient Ammonia Stress. *Environ. Ecol.* 3: 496-499.

EcoReference No.: 113390
Chemical of Concern: NHAC; Habitat: A; Effect Codes: BCM,MOR; Code: LITE EVAL CODED (NHAC).

Duration of the experiment was not 96 hours.

Sharma, S., Chanemougasoundharam, A., Sarkar, D., and Pandey, S. K. (2004). Carboxylic Acids Affect Induction, Development and Quality of Potato (Solanum tuberosum L.) Microtubers Grown In Vitro from Single-Node Explants. *Plant Growth Regul.* 44: 219-229.

EcoReference No.: 101661
Chemical of Concern: ACAC,FMA,PPA; Habitat: T; Effect Codes: BCM,GRO,POP; Code: LITE EVAL CODED (ACAC,PPA), NO EFED CHEM (FMA).

Endpoints were not reported in units that were useful to the risk assessment.

Stopar, M. (2008). Vegetable Oil Emulsions, NaCl, CH3COOH and CaSx as Organically Acceptable Apple Blossom Thinning Compounds . *Eur. J. Hortic. Sci.* 73: 55-61.

EcoReference No.: 118202
Chemical of Concern: ACAC,CaPS,Halides,NaCl,SOYBN; Habitat: T; Effect Codes: BCM,GRO,PHY,REP; Code : LITE EVAL CODED (ACAC,CaPS,Halides,NaCl,SOYBN).

Evaluated as "qualitative" and used in the risk assessment.

Taylor, P. W. and Glenn, R. A. (2008). Toxicity of Five Therapeutic Compounds on Juvenile Salmonids. *N. Am. J. Aquacult.* 70: 175-183.

EcoReference No.: 107284
Chemical of Concern: ACAC,CuS,FML,HOX,KPM; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED (ACAC,CuS,HOX), NO EFED CHEM (FML,KPM).

Endpoints were not useful and/or endpoints were not the lowest values.

Terhaar, C. J., Ewell, W. S., Dziuba, S. P., and Fassett, D. W. (1972). Toxicity of Photographic Processing Chemicals to Fish. *Photogr. Sci. Eng.* 16: 370-377.

EcoReference No.: 14566
Chemical of Concern: ACAC,Ag,Al,AlKS,BRA,CIT,FML,FeCl,FeCl3,K2Cr2O7,NACE,NH,NHTC,NHTS,Na3P; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED (ACAC,BRA,CIT,NACE), NO EFED CHEM (Al,AlKS,FML,FeCl,FeCl3,K2Cr2O7,NH,NHTC,NHTS,Na3P), OK (Ag).

Endpoints were not useful to the risk assessment.

Thompson, C. R., Kats, G., and Lennox, R. W. (1979). Phytotoxicity of Air Pollutants Formed by High Explosive Production. *Environ. Sci. Technol.* 13: 1263-1268.

EcoReference No.: 54817
Chemical of Concern: ACAC,SO2; Habitat: T; Effect Codes: PHY; Code: LITE EVAL CODED (ACAC,SO2).\

Endpoints were not reported in units that were useful to the risk assessment.

Treverrow, N. L. (1991). Rice Bloodworm, Toxicity of Fatty Acids, 1981. *Insectic. Acaric. Tests* 16: 297-(15L).

EcoReference No.: 103759
Chemical of Concern: ACAC,CAC,CRA,FMA,PPA; Habitat: A; Effect Codes: MOR; Code: LITE EVAL CODED (ACAC,CAC,CRA,PPA), NO EFED CHEM (FMA).

Endpoint was not reported in units that were useful to the risk assessment.

Union Carbide Corp. (1978). The Acute Toxicity of Sodium Acetate to the Bluegill Sunfish Lepomis macrochirus Rafinesque with Attachments and Cover Letter Dated 033178. *EPA/OTS Doc. #88-7800120* 48 p. (NTIS/OTS0200477).

EcoReference No.: 152077
Chemical of Concern: NACE; Habitat: A; Effect Codes: BEH,MOR; Code: LITE EVAL CODED (NACE).

Non-definitive endpoint and study duration was not in accord with OPP Guidelines.

Utz, L. R. P. and Bohrer, M. B. C. (2001). Acute and Chronic Toxicity of Potassium Chloride (KCl) and Potassium Acetate (KC2H3O2) to Daphnia similis and Ceriodaphnia dubia (Crustacea; Cladocera). *Bull. Environ. Contam. Toxicol.* 66: 379-385.

EcoReference No.: 62282
Chemical of Concern: KACE,KCl; Habitat: A; Effect Codes: GRO,MOR,REP; Code: LITE EVAL CODED (KACE), NO EFED CHEM (KCl).

Not the most sensitive endpoints and study duration was not always in accord with OPP Guidelines.

Van Engelsdorp, D., Underwood, R. M., and Cox-Foster, D. L. (2008). Short-Term Fumigation of Honey Bee (Hymenoptera: Apidae) Colonies with Formic and Acetic Acids for the Control of Varroa destructor (Acari: Varroidae). *J. Econ. Entomol.* 101: 256-264.

EcoReference No.: 151934
Chemical of Concern: ACAC,FMA; Habitat: T; Effect Codes: MOR,POP; Code: LITE EVAL CODED (ACAC), NO EFED CHEM (FMA).

Evaluated as “qualitative” and used in the risk assessment.

Wallace, J. M. and Whitehand, L. C. (1980). Adverse Synergistic Effects Between Acetic, Propionic, Butyric and Valeric Acids on the Growth of Wheat Seedling Roots. *Soil Biol. Biochem.* 12: 445-446.

EcoReference No.: 101600
Chemical of Concern: ACAC,PPA; Habitat: T; Effect Codes: GRO; Code: LITE

EVAL CODED (ACAC,PPA).

Mixture and units were not useful to the risk assessment.

Weissinger, W. R. and Beuchat, L. R. (2000). Comparison of Aqueous Chemical Treatments to Eliminate Salmonella on Alfalfa Seeds. *J. Food Prot.* 63: 1475-1482.

EcoReference No.: 101729
Chemical of Concern: ACAC,CIT,CaOCl,EDTA,EPXA,HOX,LLA,NaHCT; Habitat: T; Effect Codes: REP; Code: LITE EVAL CODED (ACAC,CIT,EPXA,HOX,LLA), NO EFED CHEM (CaOCl,EDTA,NaHCT).

Duration of the test was only three days.

Wu, Q. T., Deng, J. C., Long, X. X., Morel, J. L., and Schwartz, C. (2006). Selection of Appropriate Organic Additives for Enhancing Zn and Cd Phytoextraction by Hyperaccumulators. *J. Environ. Sci.* 18: 1113-1118.

EcoReference No.: 114088
Chemical of Concern: ACAC,CIT,EDTA,OXAC; Habitat: T; Effect Codes: BCM,POP,REP; Code: LITE EVAL CODED (ACAC,CIT,OXAC), NO EFED CHEM (EDTA).

Endpoints were not reported in units useful for the risk assessment.

Zurowski, D., Dobrek, L., Bugajski, A., and Thor, P. J. (2008). The Role of Sensory C-Fibers in Response of Vagal Afferent Stimulation by Gastric Distension in Rats with Experimental Chronic Gastric Ulcer. *J. Physiol. Pharmacol.* 59: 179-189.

EcoReference No.: 151795
Chemical of Concern: ACAC,CPS; Habitat: T; Effect Codes: PHY; Code: LITE EVAL CODED (ACAC,CPS).

Endpoint was not reported in units useful to the risk assessment.

Appendix A. Degradation Pathways of Sodium Diacetate (MRID 2058971)